




**Solution Partner
for Medical Engineering**
The Inspiring World of Advanced Ceramics

CeramTec
THE CERAMIC EXPERTS

Advanced Ceramics: Innovations Custom-tailored for Medical Advances

CeramTec advanced ceramics feature unique material properties, opening up enormous potential for medical engineering applications. Today and in the future. CeramTec is an international leading company in the field of advanced ceramics. With more than 100 years of experience in technical ceramics and well over 40 years of knowledge in medical engineering, we offer customers a global network of engineering and solution expertise to help them develop and implement advanced ceramics for orthopedics and arthroplasty, dentistry and medical technology devices and equipment. Our innovations have proven themselves millions of times over in series production and meet the highest medical standards. Our comprehensive medical engineering expertise covers the entire process chain, making us a leading development partner for high-performance ceramic components: from research and product ideas to material development optimized for specific applications, from innovative product design to approval and series production with state-of-the-art manufacturing technologies. Advanced ceramics from CeramTec enable innovative solutions where other materials reach their limits.





DEPENDING ON THE MATERIAL, ADVANCED CERAMICS ARE:

- Biocompatible
- Chemically resistant
- Electrically insulating
- Resistant to high temperatures
- Scratch-resistant
- Sterilizable
- Transparent
- Wear-resistant
- Corrosion resistant
- Exceptionally strong

For decades CeramTec has been a leading supplier of ceramic components for hip endoprosthesis

Helping People – with Ceramics



In the human body



In the laboratory



In the operating room



In the industrial sector

High-tech engineering: Developing series-ready innovations

For people and in people – CeramTec advanced ceramics perform their function with absolute reliability in a wide variety of daily situations across the globe. They are indispensable in critical applications and have proven their effectiveness in millions of hip replacements, dental implants and in key medical devices and systems used in ORs, hospitals, laboratory technology and the pharmaceuticals industry. CeramTec's many decades of experience in the medical engineering, electronics, device and mechanical engineering markets and chemical industry make us the ideal engineering partner and solutions provider for many demanding applications. International customers use our global reach, experience, versatility and performance capabilities to research and develop innovative system solutions together that meet the challenges of the future. As a medical engineering partner, CeramTec offers a tailored materials portfolio for greater product efficiency, safety and durability, for precision and process efficiency from the initial concept to large-scale production. In order to ensure the reliability of our processes, regular audits take place, for example through our customers, Notified Bodies, the European, American and Asian authorities as well as the FDA.

CeramTec is certified according to DIN EN ISO 13485 for medical device manufacturers. CeramTec testing and calibration laboratories have the status of international independent testing labs and are accredited according to DIN EN ISO/IEC 17025.



Improving People's Quality of Life

Partner to Millions of People

Around the globe, CeramTec stands for high-quality, bio-compatible ceramic components for hip implants and is the market leader in this field. Today, a hip joint replacement featuring CeramTec BIOLOX[®] components is implanted every 25 seconds around the world. CeramTec components are used in every second hip replacement procedure performed worldwide. More than twelve million of our components have been implanted worldwide to date. For over four decades BIOLOX[®] advanced ceramics have set standards in orthopedics. We are constantly working on ways to apply the positive properties of ceramic materials to knee, shoulder and other joint implants. Our aesthetic dental ceramics and dental products open up entirely new possibilities in modern dentistry and have helped give millions of patients a natural, radiant smile again. CeramTec's tailored range of biocompatible, low-wear and extremely durable advanced ceramics enables doctors to provide their patients with optimal care. We work in close cooperation not only with our customers who produce medical devices, but also with those who use and apply our products. This is our basis for developing new solutions that drive medical advances.



BIOLOX[®]delta ball head for hip joint replacement systems



BIOLOX[®]delta components for knee joint replacements*



High-grade dental ceramics – blanks for crowns and bridges in dentistry

*These knee implants are not approved by FDA and are not available in all countries.



Sample of a dental implant



Ceramic seal and regulator discs

Reliable Operative Care and Treatment with Advanced Ceramics



Reliable Functionality with Advanced Ceramics

When it comes to surgery and medical treatment, perfect interplay between ultra-precise technology and people is key. As a partner for medical technology, CeramTec offers its customers reliable solutions tailored to their specific use. For instance, our advanced ceramics ensure that dialysis machines, endoscopic equipment and heart pumps function reliably. Piezo-ceramic components help break up kidney and gall stones, give ultrasound diagnostics and treatment devices the necessary impulses and oscillate surgical knives and dental cleaning tools. In aerosol therapy, piezo-ceramic components are used in nebulizers. CeramCool® ceramic circuit carriers provide secure functionality and efficient heat dissipation in electronic devices as well as in power electronics and LED lighting technology. Transparent PERLUCOR® ceramics ensure a clear view, for example through endoscopic instruments. Ceramic bearings, seal rings and valve components accurately dose the required amount of medicine. Ceramaseal® hermetic feedthroughs are used in X-rays and MRI scans. Our advanced ceramics open up entirely new treatment possibilities for our customers, users and patients.



Piezo-ceramic components



CeramCool® ceramic circuit carriers



Ceramic protection and thermocouple tubes

Ensuring Perfect Precision in Analyses, Values and Processes

Reliably Determining Values with a High Level of Automation

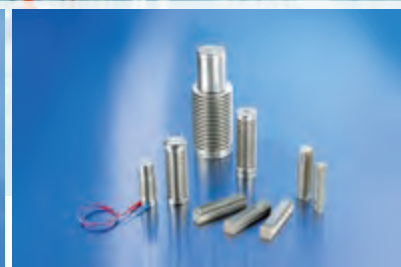
Laboratory technology for diagnostics, analysis and synthesis in medicine, chemistry, biotechnology and pharmatechnology requires high-quality devices, systems and components. Renowned customers across the globe rely on advanced ceramics from CeramTec. They contribute to precise results with high reproducibility while enabling greater automation, more reliability and cost efficiency in many different procedures. CeramTec manufactures evaporators made of porous ceramics with application-specific, precisely defined porosity for the analysis of chemical substances and gases. Lasered substrates from CeramTec are used as biochip carriers in diagnostics and analysis systems. Ceramic seal rings, bearings and seal technology works reliably in medical and laboratory analysis equipment, pumps, valves, titration systems. PERLUCOR® combines high transparency with the outstanding properties of technical ceramics like extreme resistance to wear, high temperatures, high pressures and highly corrosive media. It represents an optically perfected solution for many new transparent applications in extreme conditions. Ceramaseal® feedthroughs conduct current to the right places, even in ultra-vacuum environments. Piezo-ceramic actuators dose and control with micrometer accuracy.



PERLUCOR® – transparent, extremely wear-resistant advanced ceramics



Porous ceramics – pipes and tubes for demanding applications



Piezo-ceramic actuators



Ceramaseal® feedthroughs
for hermetic sealing



Ceramic cutters for consistently good cutting quality

Reliable Performance for Medical Engineering Devices and Equipment



Efficient Solutions for Series Production

CeramTec offers more potential for new, competitive solutions for device and equipment manufacturers. Leading manufacturers worldwide use our expertise to achieve advantages for their manufacturing processes: from applications in electronics to mechanical engineering, metalworking, plastics manufacturing all the way to printing technology and packaging. CeramTec offers ceramic dipping formers for process-reliable, large-series production of latex gloves for medical, pharmaceutical or laboratory environments. For analysis and sensor technology, our ceramic sensor components, actuators, valves, connectors and vacuum connections are used in a wide range of medical engineering applications. CeramTec's advanced ceramic materials are well suited for compact, highly integrated power electronics. CeramTec piezo-ceramic solutions work in ultrasound cleaning devices and equipment. Piezo-ceramic actuators also control the extremely thin measuring needles in high-resolution scanning electron microscopes. Ceramic cutting blades tap potential in entirely new fields of application. Our advanced ceramics are also ideal materials in grinding, mixing and dispersing processes and in mills, pumps or agitators. CeramTec ceramics contribute to safe and secure chemical processes as catalyst carriers.



Ceramic grinding discs



Ceramic catalyst carriers



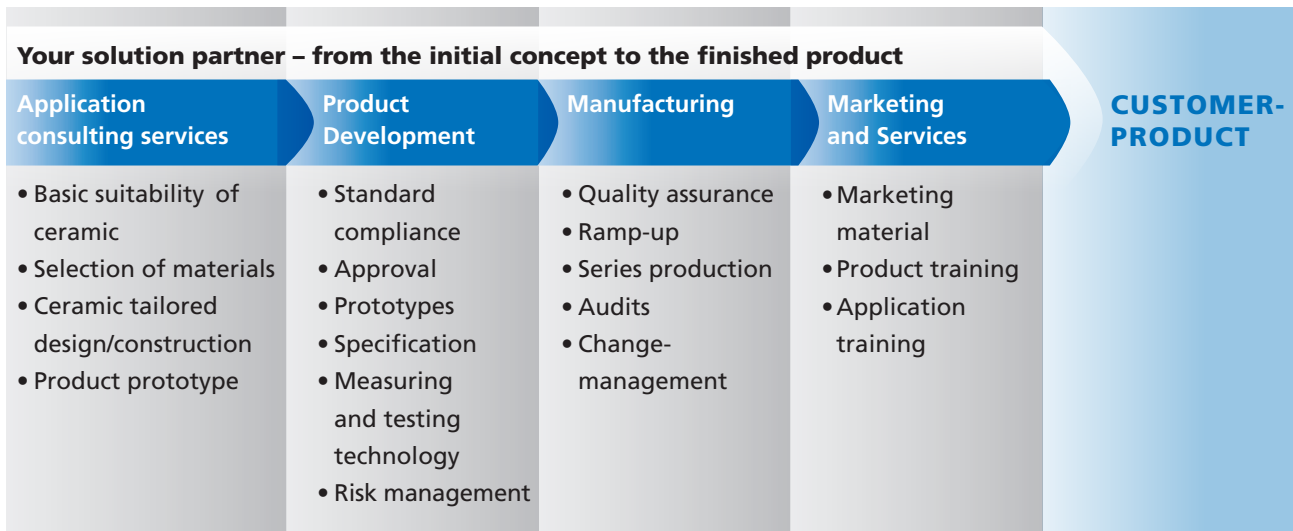
Ceramic dipping formers for glove manufacturing

Driving Developments as an Innovation Partner

Engineering for the Innovation Advantage along the Entire Process Chain

As a leading manufacturer and development partner for advanced ceramics in medical technology, CeramTec offers unique expertise in close collaboration with customers: from research and development to approval, from one-off production to large-scale series production in certified quality that has been proven millions of times over. For over four decades, we have set benchmarks for medical progress. Our advanced ceramic solutions are specifically tailored to meet demanding requirements and help us drive future advances marked by their success and high value. Our success as a development partner in the field of medical implants and medical devices and equipment is based on the constant development of new, customer-specific products. This is supplemented by expertise in material and manufacturing pro-

cesses, over 1,200 patents and the innovative strength of a team with more than 300 employees in research and development. Our creative ideas and global capability give customers a technical and economic advantage over competitors.





Special Ceramic Materials for Medical Engineering Requirements

Alumina

The most commonly used technical ceramic. In various levels of purity 80-99.97%. Excellent wear resistance, hardness, rigidity, corrosion resistance, good thermal conductivity. Ideal solution for standard applications.

Zirconium oxide

The most versatile material. Very high strength with corresponding stabilization for components subject to high stress, e.g. dental implants. Excellent wear properties against metals, also well suited for large components. Oxygen conductive, therefore in use in lambda sensors and fuel cells, among other things.

Silicon nitride

High toughness and strength, even at high temperatures, high thermal resistance. Relatively low density. For mechanical stress under aggressive conditions. Used in inter alia metal machining, roller bearings, welding rollers, drawing tools, paper industry.

Silicon carbide

Very high toughness, rigidity, corrosion resistance, high thermal shock resistance and thermal conductivity, low density. For wear applications, sealing technology, furnace superstructures, tubes for special applications. Also for complex, large-volume components.

Aluminum titanate

Very low thermal expansion and low rigidity make this material predestined for applications characterized by extreme thermal stress; maximum resistance to thermal shock, e.g. in metal melts, as an insulation material and in aggressive environments.

BILOX®delta

Alumina/zirconium oxide composite. Special combination of properties such as hardness, toughness, rigidity and wear resistance. The most-used ceramic material for joint replacement worldwide.

SHYTZ

A newly developed composite material from CeramTec. Maximum rigidity and damage tolerance, robust material properties even under extreme conditions. A new option for components subject to maximum mechanical stress.



Aluminum nitride

A ceramic specialty. Electrical insulation paired with extremely high thermal conductivity. Main applications in (power) electronics and in lighting technology for optimized thermal management.

Piezo-ceramic

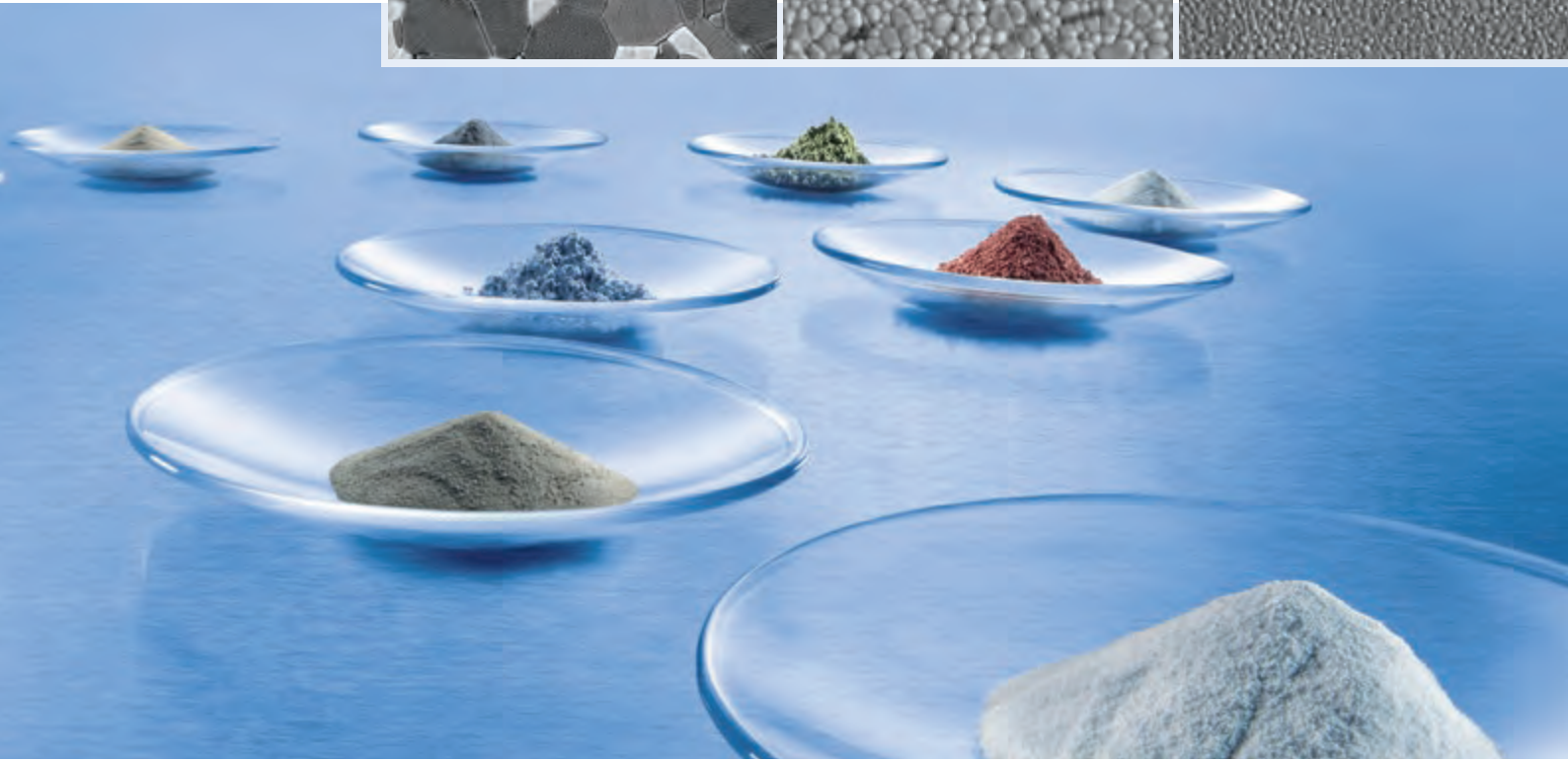
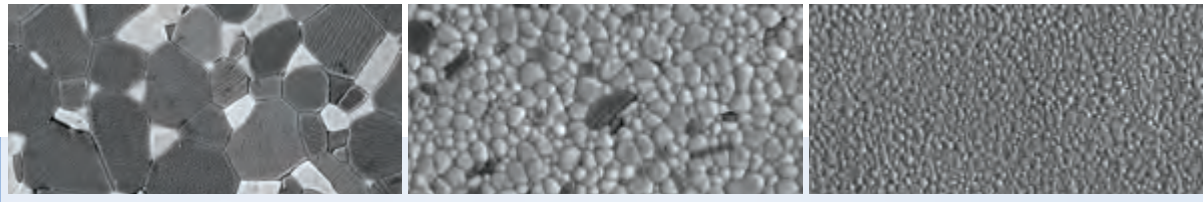
Elongates when voltage is applied or, conversely, releases an electrical charge when subject to mechanical stress. Widest range of applications as sensors and actuators, e.g. in ultrasound technology, dosing, force sensors.

PERLUCOR®

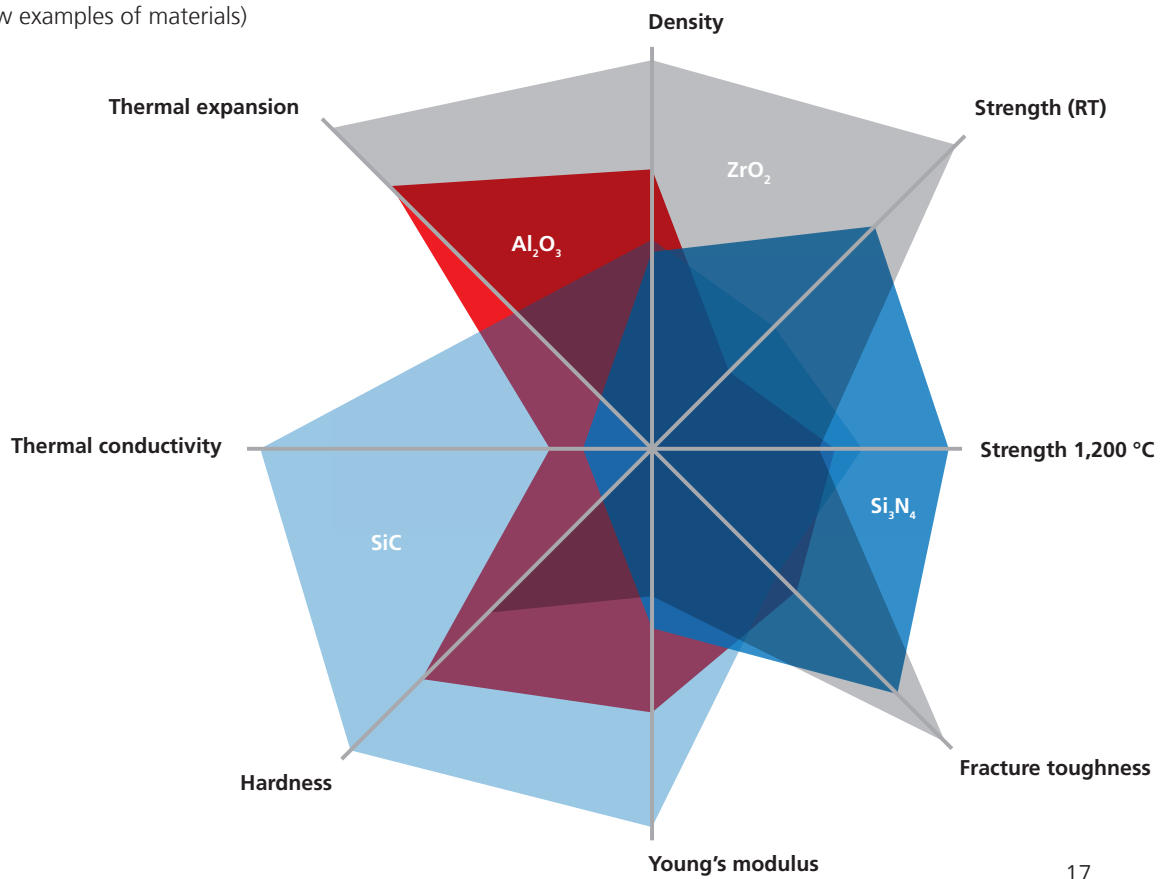
Transparent ceramic which combines the transparency of glass with the special properties of high-performance ceramics, such as very high hardness and wear resistance, temperature or chemical resistance. Fine crystalline material with associated isotropic properties and relatively good fracture toughness. Many applications, e.g. for scanners, lenses, as protective laminate in glass/lenses subject to stress.

Cubic boron nitride

Very similar to diamond, extremely high hardness, but less brittle and significantly higher chemical resistance. Used in steel machining and as a cutting tool under the most extreme conditions.



Optimum, customized solutions that utilize the property profiles of selected materials (these are just a few examples of materials)



Advanced Ceramics – Property Comparison

New Paths for the Future

More and more, advanced ceramics are used where materials such as metals or plastics do not ideally fulfill existing requirements or when application challenges cannot be overcome with conventional materials. We are constantly searching for new ways to further optimize ceramics in medical applications so that we can offer solutions for the development and production of innovative medical devices and equipment. Thanks to their tailored profile of mechanical, electrical, thermal and biochemical property combinations, our advanced ceramics enable one-of-a-kind, pioneering solutions with even greater potential. Our specially developed materials and components can be optimally adapted to meet and solve customer-specific requirements and problems.

Be inspired by advanced ceramics – the material of the future, superior to other materials. We are the solution partner for your application.

Strengths of ceramics* compared to other materials

Material properties	CERAMIC	METAL	POLYMERE
Biocompatibility	+	•	+
Prevention of allergic reactions	+	•	•
Hardness	+	-	-
Wear resistance	+	-	•
Weight savings	•	-	+
Dimensional stability	+	-	-
Corrosion resistance	+	-	-
Risk of breakage	•	•	•

+ advantageous • neutral - less advantageous

*Depending on the material, advanced ceramics have different properties

Corrosion resistant

Electrically insulating

Sterilizable

Biocompatible

Chemically resistant

Scratch-resistant

Resistant to high temperatures

Exceptionally strong

Wear-resistant

Transparent

CERAMICS*

METALS

POLYMERS

